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Director of Central Intelligence

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National Intelligence Estimate

The Future of Soviet Science

Key Judgments

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NIE 11-7-85
November 1985

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THE FUTURE OF SOVIET SCIENCE

KEY JUDGMENTS

The full text of this Estimate is being published separately with regular distribution.

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THIS ESTIMATE IS ISSUED BY THE DIRECTOR OF CENTRAL INTELLIGENCE.

THE NATIONAL FOREIGN INTELLIGENCE BOARD CONCURS.

The following intelligence organizations participated in the preparation of the Estimate:

The Central Intelligence Agency, the Defense Intelligence Agency, the National Security Agency, and the intelligence organization of the Department of State.

Also Participating:

The Assistant Chief of Staff for Intelligence, Department of the Army

The Director of Naval Intelligence, Department of the Navy

The Assistant Chief of Staff, Intelligence, Department of the Air Force

The Director of Intelligence, Headquarters, Marine Corps

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SCOPE NOTE

This Estimate addresses the sector of Soviet society at the very leading edge of future technology development—the sciences. The sciences, under which we include fundamental and applied science, are concerned with the discovery and conceptual development of new laws of nature and the preliminary steps taken to explore possible applications of these discoveries.

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Science, and in particular fundamental science as distinguished from applied science, is so far removed from weapon systems, products, and processes that have an obvious effect on our relations with the USSR that it is difficult to convey with clarity the far-reaching and long-term effects it has on societies. However, science serves as the wellspring of new concepts and theories from which new technologies, and finally products and processes, evolve. An understanding of Soviet science, consequently, can provide the first indications of fundamentally new approaches to problems of defense and the economy. These early indicators can serve to alert the Intelligence Community to areas where the Soviets are particularly strong and where surprises are likely to be in store. More generally, an overall sense of the state of Soviet science, as well as how it couples to industry, can contribute a background of reality against which to evaluate the viability of intended policies and programs initiated by the Communist Party of the Soviet Union

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The intent is to develop, in a broad sense, an understanding of the current health of Soviet science and to speculate on the implications of its current and likely future course. This entails an understanding of the environment within which Soviet science is conducted, in addition to a general assessment of the relative strength of Soviet scientific research in various fields of science as compared with that in the United States. We have tried to identify and discuss the implications of the striking differences between the Soviet and US research environments in such areas as organization and management, resources, science policy and education, and the nature of the Soviet scientist.

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We have limited this study primarily to science sponsored by the Soviet Academy of Sciences, and, furthermore, primarily to the physical sciences; we have also collected data and impressions on applied science in industrial research institutes as well. We believe, however, that the environmental factors identified are generally applicable in describing the conditions for all of Soviet science. In addition, we have explored somewhat the transition of science and technology to industry

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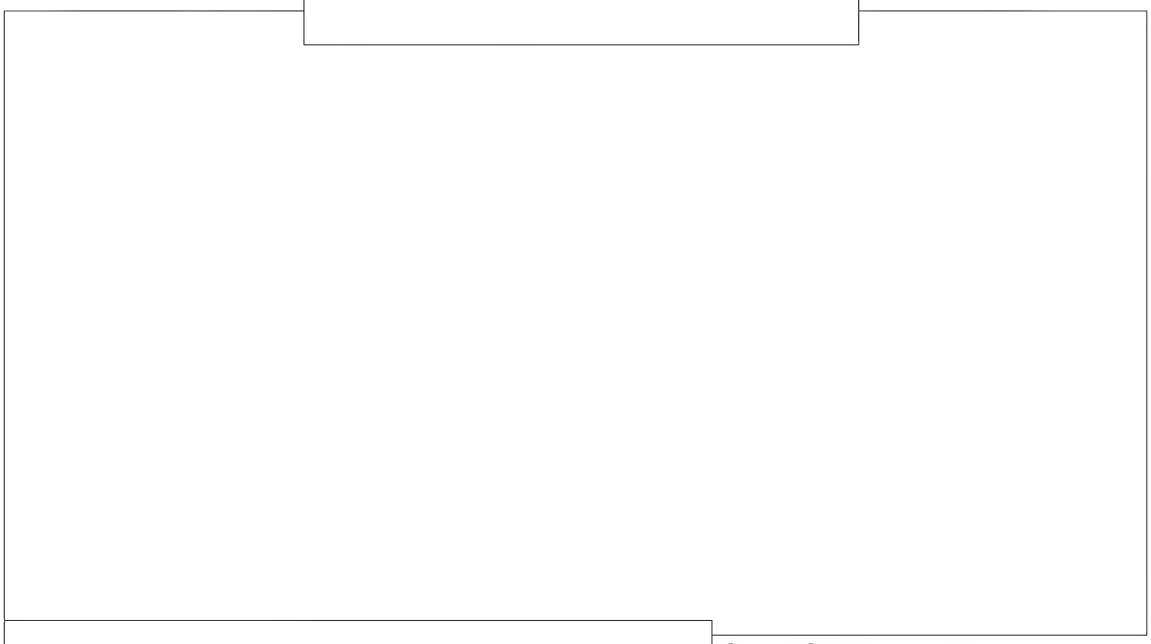

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the judgments were cross-checked against several studies/reports/surveys that were conducted outside of the Intelligence Community. We found the themes to be largely consistent among these various sources.

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We do not attempt to provide an in-depth analysis of Soviet scientific capability; rather we have focused on the research environment, policy, resources, and scientists that affect science in the Soviet Union

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This study is intended to break ground in developing an understanding of Soviet science, and to serve as a basis upon which further analysis may build a more complete and detailed picture

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KEY JUDGMENTS

Soviet science may undergo a gradual evolution over the next two decades, which could result in a more effective system for responding to the technology needs of the country. Over the next decade, party policy initiatives from the new-generation leaders, which have been designed to focus Soviet scientific talent on economically and militarily relevant research, could result in a reduction or leveling off of Soviet research in areas of fundamental science having little or no obvious applications. Beyond that time, an improved technology base could result in a significant reduction in the problems imposed by the Soviets' traditional lack of instrumentation and computing power. This, coupled with their large applied science effort, could allow them to overcome more easily future technical deficiencies in their military systems and civilian products, thus increasing their competitiveness.

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The transfer of science to technology and application is difficult for the Soviets because of:

— An incentive system that does not strongly support technical innovation and implementation.

— Restricted communication.

— A rigidly hierarchical bureacracy that does not easily allow interministry scientific projects.

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It is likely that the new generation of Soviet political and scientific leaders will institute substantive changes that affect both the S&T administrative bureaucracy and the research environment, which could improve the science-to-technology transition problems and the inadequate instrumentation infrastructure:

— We expect that substantial impact resulting from any changes will be slow and gradual, and that the current research problems are likely to continue for the next 10 years.

— Beyond that time, however, if the new generation of leaders is successful in instituting changes, we may expect to begin to see substantial impact on the Soviet technology base.

— Many new leaders in the scientific community are also of the new generation and have made their careers in applied science. They may be expected to perpetuate any changes over at least two decades.

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There will probably be a further shift of Soviet scientific research toward applied sciences in the future:

— Should the Soviets be successful in improving their ability to move science to technology and application, the expected increasing focus on applied science, combined with their demonstrated ability to come up with new scientific concepts, could lead to an increased likelihood that the United States may be surprised by an unanticipated applied scientific development. The occurrence of such a surprise in applied science could in a short time impact on militarily and economically important technologies.

— This shift will probably substantially affect the Soviet Academy of Sciences and result in a reduction or leveling off of fundamental science, particularly experimental science, although a smaller core of scientists can be expected to continue to produce world-class scientific results.

— Some areas of fundamental science that have traditionally been closely coupled to applications, such as condensed matter physics and semiconductors, may in fact receive greater emphasis.

— A greater reliance on the West for fundamental scientific research can be expected in the future.

— Even after the technology base begins to respond substantially to the new policies, vigorous Soviet efforts to acquire Western technology can be expected to continue.

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The best Soviet *theorists* have capability comparable to that of their Western counterparts in all fields of physical science.

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Soviet theoretical research is largely comparable in scope and quality to that in the West:

— The Soviets are particularly noted for their strength in turbulence, plasma physics, laser physics, mathematics, and astrophysics.

— The Soviets' lack of large-scale scientific computers for computational physics may limit their contribution in the future.

— US scientists have attributed the Soviet absence in, for example, the band theory of conduction to inadequate computer power.

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The best Soviet *experimentalists* are just as good intellectually as their Western counterparts:

— The Soviets have been lauded for their contributions in materials science and laser physics.

— They are, however, frequently limited by problems with quality, availability, and maintenance of instrumentation.

— Nevertheless, the Soviets frequently surprise Western scientists with the quality of the data they obtain with relatively crude equipment, and they often demonstrate a deeper physical insight.

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In scope and quality, the Soviets' experimental research is generally not on a par with their theoretical research. The Soviets have been conspicuously absent in some fields, in large part because of the lack of necessary techniques and equipment:

— Such has been the case in surface physics, where the availability of ultrahigh vacuum techniques is essential.

— Lack of sophistication in vacuum and cryogenic technology has limited Soviet contributions in low-temperature physics.

— While ultrafast laser spectroscopy has been a major interest in the United States, the Soviets have been slower to achieve extremely short time resolutions.

The presence of just a few very bright scientists can, and has, made the difference between very significant Soviet contributions in a field and the virtual absence of a Soviet contribution. Even where the Soviet contribution is significantly poorer than that of Western countries, as in biological sciences and molecular biology in particular, it is possible to find specific examples within the broad field, such as biophysical chemistry and protein conformation, that are regarded as world class by Western scientists.

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Soviet scientists generally show an overall excellence in mathematics education, which exceeds that of their Western counterparts. This has:

— Contributed to excellence in theoretical physics.

— Allowed them to circumvent inadequate computer capability to some extent, thereby allowing analytic solutions where Western scientists would be more likely to pursue a numerical solution.

— Allowed adequate numerical results to be obtained on computers of comparably lesser capability in some cases.

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Should state-of-the-art computers become available to the Soviets, the possibility of a surge in their scientific computation capability exists because of their excellence in mathematics:

— This surge could be mitigated to some extent because of the need for special programing knowledge and experience. 25X1

Soviet scientists are often the first to come up with a new scientific concept, but generally the USSR lags the West in fully developing the idea. Such has been the case, for example, with the Tokamak for controlled thermonuclear fusion, and optical phase conjugation, which can be used in correcting atmospheric distortion of electromagnetic wave propagation. (U)

Restricted freedom of communication is a fundamental flaw in the Soviet scientific research environment that results in:

— Reduced synergism among scientists.

— Duplication of effort despite central planning.

— Slow diffusion of new ideas and technologies.

— Errors resulting from inadequate peer review. (U)

The best Soviet students have had depth, breadth, and quality of scientific education comparable to that of their US counterparts. They generally have greater mathematical expertise than their US counterparts, however. 25X1

Because teaching and research are largely separated institutionally, the interchange of ideas between researchers, professors, and students is reduced:

— Soviet awareness of this situation has resulted in efforts to decrease the separation, but the problem persists.

— Students often need substantial retraining to participate effectively in a research institute. 25X1

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